Effective Adaptation Technique for Hexahedral Mesh

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Abstract

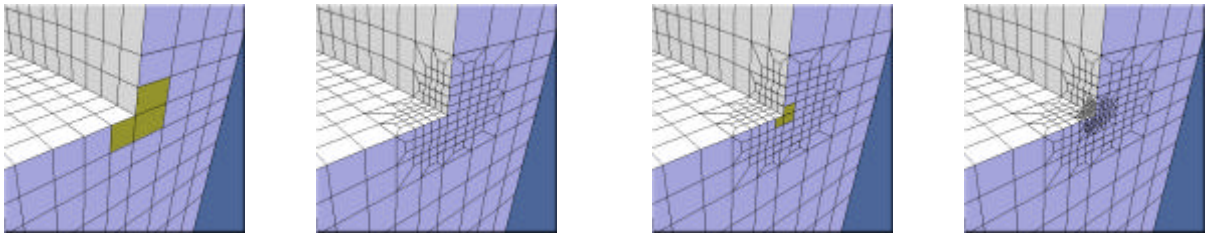
This paper describes easy and effective adaptive technique for Finite Element Method. Utilize Hex-R which refine an existing mesh. Refined mesh keeps original coarse mesh topologically. Finally capability of adaptive method using Hex-R is mentioned.

Introduction

Adaptive technique is one of the most important issues in order to realize effective FEM analysis process. Many works for adaptive mesh generation and error estimation are conducted. But there is a problem that is very complex implementation of such kind of system. Especially mesh generation is difficult issue, because there is no guarantee to succeed in a complete mesh generation with arbitrary shape and node distribution. Proposal mesh refinement method which is based on local mesh refinement [1] utilizes original mesh connectivity. In other words new fine elements are generated in each element. Proposal method can guarantee to generate a refined mesh for adaptation.

Mesh Refinement Tool: Hex-R

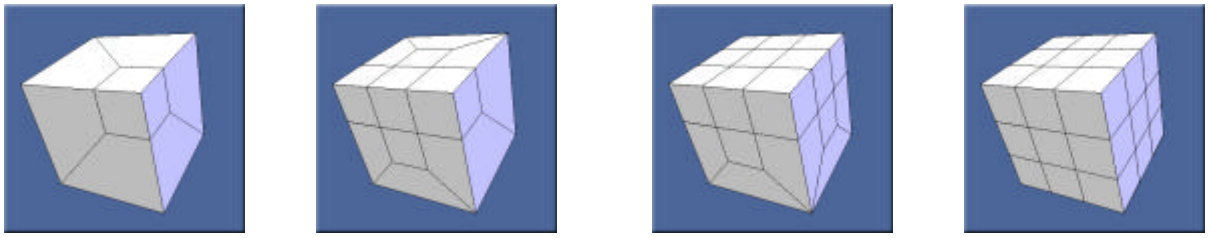
Figure 1 shows an example of recursive refinement using Hex-R[1]. Hex-R reads numbers of elements to be refined and write a refined mesh out. Figure 1 shows a process of recursive mesh refinement. Firstly elements to be refined are selected in Figure 1(a). The Hex-R generates a refined mesh as shown Figure 1(b). Secondly the elements are selected again in Figure 1(c). The same process is conducted and more refined mesh is obtained as shown in Figure 1(d). This process can be performed by GPPView[1].



(a) Initial Selection (b) First Refinement (c) Second Selection (d) Second Refinement

Figure 1: Recursive Mesh Refinement using Hex-R

There are four patterns in the mesh refinement. Pattern 1 is applied at the corner of refining region. Pattern 2 is applied between Pattern 1. Pattern 3 is applied elements beside selected elements. Fourth pattern is applied at a selected element which divided into 27 hex elements. Especially Pattern 1, Pattern 2 and Pattern 3 are called as transition pattern. These three patterns must be located around Pattern 4, because all elements should be placed with consistency.

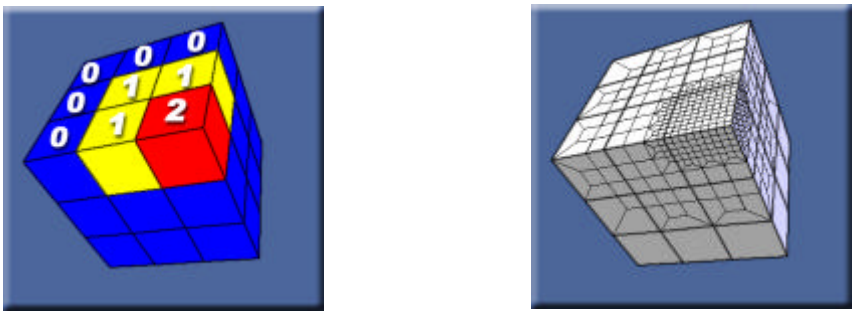


(a) Pattern 1 (b) Pattern 2 (c) Pattern 3 (d) Pattern 4

Figure 2: Refinement Patterns

Adaptation using Hex-R

Hex-R can easily create an adaptive mesh. Of course there are some limitations. Firstly, this method is not a regeneration method. It is a refining method which means elements will be subdivided into fine elements. Secondly a shape of refining area must be concave.
On the other hand the limitation reduces complexity and failure of the mesh generation. Figure 3 illustrates simple case of adaptive data and a mesh. Figure 3 (a) shows adaptive information which is how refining a mesh. Figure 3 (b) shows a mesh refined by the adaptive information.
In order to generate an adaptive mesh, a result of error estimation or physical values should be converted to information for subdivision of each element as shown in Figure 3(a). There are three kinds of subdivision information in Figure 3 (a). Blue area denoted by 0 represents not to be subdivided. Yellow area denoted by 1 represents that each element are divided into 27 elements respectively. Red area denoted by 2 represents to be divided into 729 elements.



(a) Adaptive information on initial mesh (b) Refined Mesh for adaptation

Figure 3: Adaptive Instruction and actual mesh

Conclusion

We propose an effective mesh refinement method and adaptive mesh generation method. In further research we will apply the method to the several analyses and evaluate effectiveness.

References

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